# Biodiversity of Coastal Marine Ecosystems

# Pattern and Process - A Euroconference

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Topics:

1. General patterns in marine biodiversity
2. Patterns of coastal marine biodiversity in major groups
3. Patterns of biodiversity in different habitats
4. The human factor
5. Methodology, European Co-operation, End Users

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# Ciliate Microzooplankton, An Example of Congruence of Local and Regional Diversity

*Patterns of coastal marine biodiversity in major groups*


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Microzooplankton occupy a key position in planktonic food webs, linking algal and bacterial production to higher trophic levels and among the microzooplankton, ciliate protists often dominate. Tintinnids, characterized by the possession of species-specific loricas or shells, are a ubiquitous component of marine ciliate communities. Among sea microbes, tintinnids are unique because they are both quantitatively important in food chain dynamics and a group in which species identifications are based largely on gross morphology of the lorica. In contrast with most microbial groups, identifications can be made using the relatively low tech method of light microscopy and the exploitation of comparative data gathered over the past 100 years is possible. I examined species and morphological diversity of tintinnids in 2 systems, the Mediterranean Sea and the Chesapeake Bay to compare tintinnid diversity patterns with those of other taxa. Mediterranean samples were used to investigate relationships between resources and diversity over a large spatial scale. Correspondence of tintinnids with typical estuarine diversity patterns was examined in Chesapeake Bay tintinnids.

In the Mediterranean Sea, a longitudinal gradient of chlorophyll concentrations and primary production is found, rather than the latitudinal gradient of the world ocean. Samples from oceanographic campaigns in June and September were employed to compare diversity of tintinnids to availability of food resources in the form of chlorophyll stocks or primary production. June samples, gathered in 1992 and 1996 (see Dolan 2000), showed a distinct gradient of increasing diversity from west to east corresponding to reductions in chlorophyll stocks and a deepening of the chlorophyll maximum layer. The gradient of taxonomic diversity (numbers of species, genera, and values of H') corresponded roughly with morphological diversity, in the form of SD's of lorica length but not oral diameter. The lack of relationship between taxonomic diversity and the variance of oral diameters lent little support to the idea that taxonomic diversity was linked to resource or feeding diversity. However, there was little data available on the composition the phytoplankton. Thus, while a longitudinal trend was found, analogous to the latitudinal diversity gradient found among many groups in the world ocean, the mechanism was obscure.

In September 1999 a campaign which sampled waters from the Moroccan upwelling system to the eastern basin of the Mediterranean provided samples for tintinnid studies as well as detailed phytoplankton pigment data. The September pattern of tintinnid diversity differed considerably from that based on June samples. While chlorophyll and primary production again declined from west to east, tintinnid diversity increased from west to east but reached a plateau in the central basin. Morphological diversity, as H' values for size-classes of oral diameters and lorica lengths, paralleled taxonomic diversity. Phytoplankton accessory pigment data permitted division of the chlorophyll crop into 3 size-fractions, pico, nano and micro-chlorophyll (see Vidussi et al. 2001). Considering each size-fraction as a separate species allows calculation of a crude index of phytoplankton 'size-diversity' (chlorophyll-size H'). This metric of tintinnid food-resource diversity was correlated with tintinnid taxonomic and morphological diversity. Along a large geographic gradient (e.g., 10°W -> 25°E) taxonomic diversity can be linked to morphological diversity which

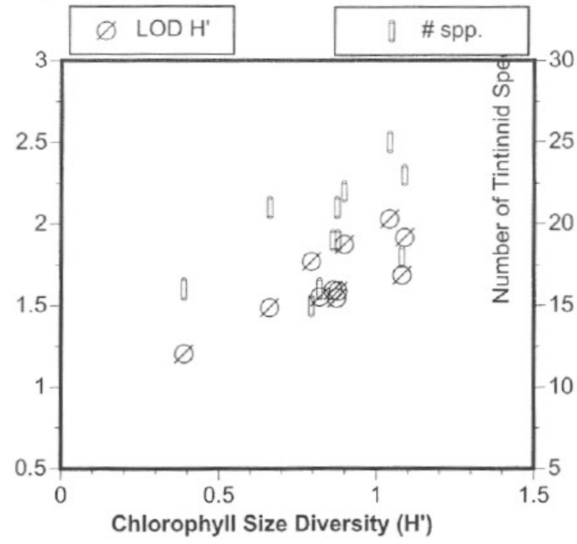


*Figure 1. The relationship between resource diversity (size-class diversity of the chlorophyll crop) and tintinnid morphological and taxonomic diversity in terms of oral diameters (LOD) or numbers of species (# spp).*

On a smaller spatial scale, a direct comparison of tintinnid diversity with patterns reported for other groups was made in the Chesapeake Bay, a large, eutrophic, coastal plain estuary. Estuaries are typically described as low-diversity environments in which for a given group, biomass decreases and diversity increases with salinity. Tintinnid diversity appeared unrelated to salinity and population density. Diversity was remarkably high, comparable to that of the oligotrophic eastern Mediterranean but along a spatial gradient of $10^1$ km, no clear trends were evident, in contrast to the patterns found in the Mediterranean at a scale of $10^2$ km.

The similarity of average values of diversity metrics in 2 very distinct systems whose only obvious common characteristic is latitude (both range from about 37°N – 40°N) prompted an examination of latitudinal trends using easily available literature reports giving numbers of species found at single points and single times (regardless of sampling method); maximum species numbers were chosen when a range was reported. The results (Figure 2) suggested that over a global scale a clear gradient was apparent with latitude a better predictor of species abundance than type of environment (e.g., estuary vs. oligotrophic marine), over very large geographic scales ($10^3$ km).

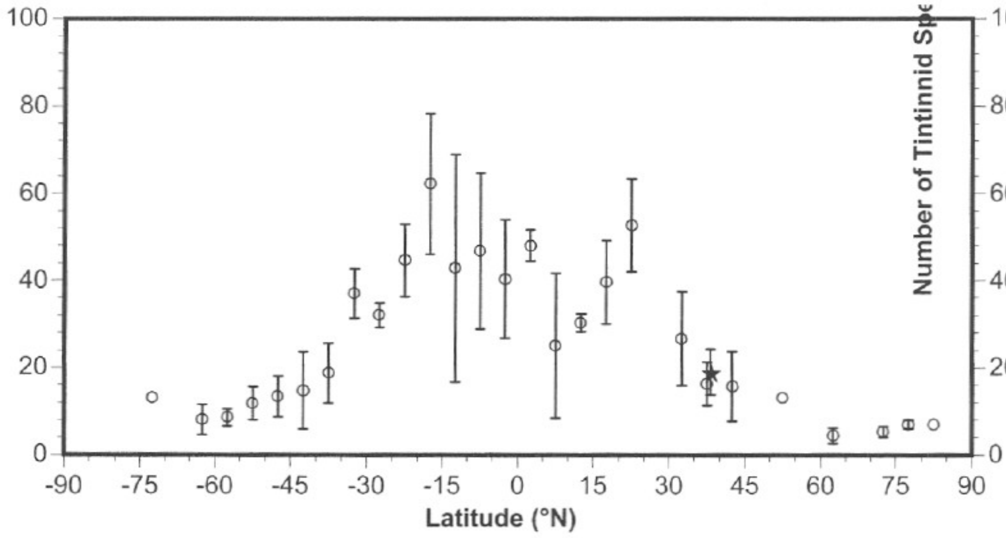


*Figure 2. Latitudinal trends in tintinnid species abundance, based on literature reports. Maximum species abundance for individual locations (n = 168) were averaged (±sd) within sets of 5° of latitude and were plotted against the mid-points of the 5° bands. Regression relationships are for the southern latitude estimates (n = 13), $r^2 = 0.75$, $x = 0.703 * lat + 0.531$ and for the northern latitudes (n = 13): $r^2 = 0.70$, $x = -0.50 * lat + 0.452$.*

Over small spatial scales ($10^1$ km) diversity can appear unrelated to either physical conditions of the water column (e.g., turbulence) or biological (e.g., chlorophyll concentrations). Over large spatial scales ($10^2$ km), patterns emerge as water column conditions shift dramatically. However, over very large spatial scales ($10^3$ km) local diversity appears to reflect regional diversity, which may in turn be governed by such factors as temperature constraints on geographic ranges of individual species.

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*Patterns of coastal marine biodiversity in major groups*

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